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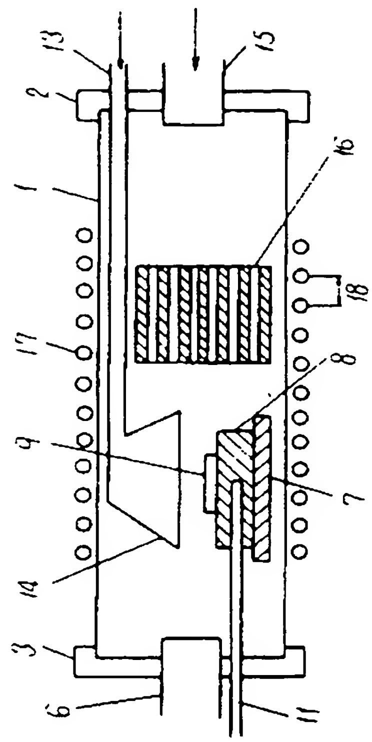
TITLE : DEVICE FOR VAPOR DEPOSITION



ABSTRACT : PURPOSE: To form a vapor phase epitaxially grown layer of the crystal of a compd. semiconductor in a short time in the vapor deposition stage of the crystal of the compd. semiconductor on the surface of a substrate in a furnace core tube by heating the substrate and reacting gases in the furnace core tube.

CONSTITUTION: A crystal substrate 9 of a compd. InP is placed on a susceptor 8 made of SiC-coated graphite on a boat 7 in a furnace core tube 1. A hood 14 is provided so as to cover the substrate 9. Gaseous triethyl indium is supplied from the outside through a conduit 13 into the core tube, and gaseous PH_3, AsH_3 are supplied therein through a conduit 15 so that the thin film of the crystal of a compd. semiconductor of InP is vapor-deposited epitaxially on the surface of the substrate 9. A susceptor 8 is heated with a high-frequency induction heater 17 to heat the substrate 9 thereon. Similarly, heating blocks 16 made of SiC-coated graphite are heated to heat gases such as PH_3 and AsH passing therethrough, whereby the rate of the vapor phase epitaxial growth is improved.

F2 Spec

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㉞気相成長装置

㉑特　　願　昭57—19233

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明　　細　　書

1、発明の名称

気相成長装置

2、特許請求の範囲

(1) 炉芯管と、前記炉芯管に置かれた基板の基板表面上部に噴出口を具備する第1のガス供給ラインと、前記炉芯管の一方の端部に設けられた第2のガス供給口と、前記炉芯管を加熱する加熱部とを有することを特徴とする気相成長装置。

(2) 炉芯管内に置かれた基板と第2のガス供給口の間に加熱ブロックが設けられていることを特徴とする特許請求の範囲第1項に記載の気相成長装置。

3、発明の詳細な説明

本発明はInP系の化合物半導体の良好な成長層を得ることが出来る気相成長装置に関する。

Ⅲ－Ⅴ化合物半導体のエピタキシャル成長法としては液相成長法と気相成長法があり、量産化には気相成長法が適している。特に、気相比と固相比が殆ぼ等しくとれ、ハライド法に比べ制御性がすぐれている方法としてMOCVD法（Metal-Organic-CVD）がある。

第1図に従来のMOCVD法を示す。同図において、炉芯管1の両端部にエンドキャップ2，3を設けてあり、エンドキャップ2にはガス供給管4，5が設けてある。InPを結晶成長する場合は、例えば有機金属としてTEI（トリエチルインジウム）をガス供給管4に、PH_3ガスをガス供給管5から独立に炉芯管に供給する。炉芯管1内を流れ出たガスは出口6より排気される。ボート7上のサセプター8はSiCコーティング製のグラファイトで、その上に基板9が載置されている。基板9の加熱は高周波コイル10による高温加熱である。基板9の温度は熱電対11により検知し、通常フィードバックをかけ一定温度調節を行なう。

この装置で、たとえばInp基板上にInPをエピタキシャル成長を行なう場合、TEIの輸送量、pH_3の輸送量、成長温度を変えてみても、その成長速度は著しく遅い。例えば、TEIを66℃の恒温槽に置き、100cc/minのH_2でバブリングし、

及びPH_3 ２％ H_2ベースガスを２００cc/minを１ℓ/minのH_2キャリアガスで輸送して、成長温度６５０℃で９０min間の処理で、～０.１μmのInpのエピタキシャル層が基板９上に形成される。

しかし、成長速度が遅く実用的でない。この様に成長速度が遅いのはpH_3の分解がうまくゆかず、PH_3がTEIと反応して$(C_2H_5)_3 \cdot PH_3$のようなComplexを形成して、Inp成長を阻止するからである。

そこで、加熱炉１２をpH_3ガスラインであるガス供給管５に設け、７００℃程度に加熱してPH_3の分解を促す方法がある。この方法だと成長速度も少しよくなるが基板９以外にもInPの成長があり、TEIのInとの反応領域に損失がある。又、加熱炉１２と反応炉の炉芯管１とを近接しないと、その間のガス供給管５の管壁にPが付着してしまい効率が悪い。更に、この場合は加熱炉１２内のガス供給管５領域は石英質の構造にする必要があり装置が複雑となる傾向がある。

本発明は上記点にかんがみ、良好なInP系のエピタキシャル成長層を速く形成出来る気相成長装置を提供せんとするものである。

第２図に本発明に係る実施例を示す。同図において、第１図と同一番号は同一部物を示しており炉芯管１へのガス供給はTEI等の有機金属系用としてガス供給管１３を用いて行なわれる。ガス供給管１３の先端部はフード１４が形成されており、フード１４は基板９表面上部をおおう様設置されている。成長速度及び結晶性はフード１４の形状，構造及びフード１４と成長用基板９との間隙寸法等によって異なる。pH_3，AsH_3系はガス供給管１５から炉芯管１内に導入し、SICコーティングのグラファイト製加熱ブロック１６を介して成長用基板９近傍におくりこむ。グラファイト製加熱ブロック１６は適当な複数個の貫通穴が設けられ、ガスが均熱に加熱されるようにする。尚、この加熱ブロック１６はフード付ガス供給管１３の支持台にも兼ねることができる。成長用基板９のサセプター８及び加熱ブロック１６の加熱は高周波加熱コイル１７で一度に行なう。尚、加熱ブロック１６とフード付ガス供給管１３とを余り近づけると、加熱ブロック１６の蓄熱によりガス供給管１３の内壁にガスが反応付着してしまうので、両者はなるべく離した方が好ましい。pH_3のプリヒート用としての加熱ブロック１６の温度を高くしたい場合は高周波加熱コイル１７の間隙１８を狭くすればよい。

成長条件として、たとえば、TEI（５０℃加熱）を１００cc/min H_2でバブリングし、pH_3 ２％を２００cc/minでキャリアH_2ガス１ℓ/minで供給し、成長温度６００℃、pH_3のプリヒートの加熱ブロック１６近傍を７００℃に設定するとInp基板上に１時間で約３～５μmのInpが成長し、従来に比して数十倍の成長速度が得られる。

尚、上記実施例において、Inp系の気相成長について述べたが、本発明はInp系と同様な反応過程を有するものであれば別の化合物半導体層のエピタキシャル成長にも適応出来ることは云うまでもない。

以上、本実施例ではTEI等の有機金属をフード形式で基板近傍までガイドし、かつpH_3等のガスはプリヒートして基板に供給しているので、Inp系結晶の成長層を速く形成することが可能で、そしてガス供給管及びプリヒート用加熱ブロックは着脱式のため、管内のクリーンニングは容易である。

以上の様に、本発明は簡単な構成で高速にかつ良好な成長層を形成出来るので、Ⅲ－Ⅴ，Ⅱ－Ⅵ系化合物半導体の成長層形成の量産化に適するものであり工業的価値は高い。

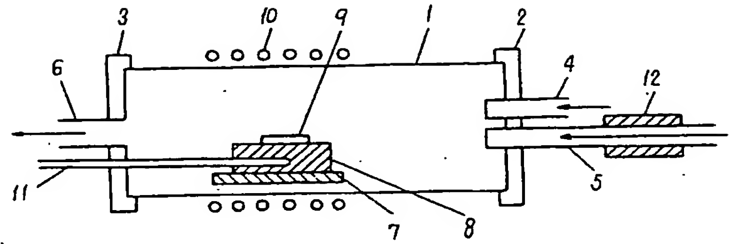
４、図面の簡単な説明

第１図は従来の気相成長装置の概略図、第２図は本発明に係る実施例の気相成長装置の概略図を示す。

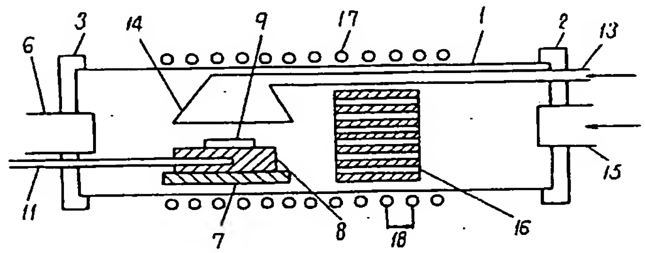
１……炉芯管、７……ボート、８……サセプター、９……基板、１３……フード付ガス供給管、１４……フード、１５……ガス供給管、１６……グラファイト製ブロック。

代理人の氏名　弁理士　中 尾 敏 男　ほか１名

第 1 図



第 2 図



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Inventors: Ogura; Motoji et al,

Applicant: Matsushita Electric Industrial CO.,Led

SPECIFICATION

TITLE OF THE INVENTION

VAPOR PHASE DEPOSITION DEVICE

Claims:

1. A vapor phase deposition device equipped with a reactor core tube, first gas supply line having an injection port over the upper surface of the substrate placed in the above reactor core tube, second gas supply port positioned at one end of the above reactor core tube, and heating section for heating the above reactor core tube.

2. The vapor phase deposition device according to Claim 1, wherein a heating block is provided between said substrate placed in said reactor core tube and second gas supply port.

DETAILED DESCRIPTION OF THE INVENTION

This invention relates to a vapor phase deposition device which can produce a high-quality deposition layer of an

InP-based compound semiconductor.

The methods for epitaxial growth of compound semiconductor of Group III and V elements fall into two general categories, liquid phase and vapor phase deposition, the latter being more suitable for massive production. In particular, the MOCVD (metal-organic-CVD) method is capable of keeping the vapor phase ratio almost the same as the solid phase ratio, and more controllable than the halide method.

Fig.1 shows the conventional MOCVD method, wherein the reactor core tube 1 is provided with the end caps 2 and 3 at both ends, and the end cap 2 is provided with the gas supply tubes 4 and 5. When the InP crystal is to be grown, an organic metal compound, e.g., TEI (trimethyl indium), and PH_3 gas are supplied to the reactor core tube 1 separately via the gas supply tubes 4 and 5, respectively. These gases flow through the reactor tube 1 and are discharged therefrom through the outlet port 6. The susceptor 8 supported by the boat 7 is made of graphite coated with SiC, and supports the substrate 9. The substrate 9 is kept at high temperature by the RF coil 10. Its temperature is sensed by the thermocouples 11, and a feed back loop is normally provided to keep it at a constant level.

Rate of epitaxial growth of, e.g., InP, on an InP substrate in this device is very low, even when feed rates of TEI and PH_3 and growth temperature are changed. For example, an approximately 0.1μm thick epitaxial layer is formed on the

substrate 9, when TEI placed in a constant-temperature bath kept at 65°C is bubbled with H_2 flowing at 100cc/minute, a H_2-based gas containing 2% of PH_3 is charged at 200cc/minute while being carried by H_2 flowing at 1l/minute, and the crystal is grown at 650°C for 90 minutes. This growth rate is impractically low. Such a low growth rate results from insufficient pyrolysis of PH_3, as it reacts with TEI to form a complex, e.g., $(C_2H_5)_3 \bullet PH_3$, to retard growth of InP.

One approach for accelerating pyrolysis of PH_3 is to install the furnace 12 in the gas supply tube 5 as the PH_3 gas supply line and heat it at around 700°C. This accelerates growth of the crystal to some extent, but grows InP on a site other than the substrate9, causing loss of the reaction region for TEI and In. Its another disadvantage is deteriorated efficiency, unless the furnace 12 and reactor core 1 in the reaction furnace are sufficiently close to each other, because of deposition of P on the tube walls between them. Moreover, it is necessary for the gas supply tube 5 region in the furnace 12 to be structurally made of quartz, which tends to make the device more complex.

It is an object of the present invention to provide a vapor phase deposition device which can accelerate formation of high-quality epitaxial growth layer of InP-based material, in order to solve the problems involved in the conventional device.

Fig.2 illustrates one example of the present invention, wherein the same member as that shown in Fig.1 is marked with the same number. An organometallic gas, e.g., TEI, is supplied to the reactor core tube 1 via the gas supply tube 13, provided with the hood 14 at one end in such a way that it cover the upper surface of the substrate 9. Growth rate and crystallinity of the crystal vary depending on, e.g., shape and structure of the hood 14 and also on gap dimensions between the hood 14 and substrate 9 on which the crystal is grown. The PH_3- or AsH_3-based gas is introduced into the reactor core 1 via the gas supply tube 15, to the vicinity of the crystal-growing substrate 9 via the heating block 16 of graphite coated with SiC. The heating block 16 of graphite coated with SiC is provided with an adequate number of through-holes to help heat the gas uniformly. The heating block 16 may also serve as a supporting table for the hood-equipped gas supply tube 13. The susceptor 8 for the crystal-growing substrate 9 and heating block 16 are simultaneously heated by the RF heating coil 17. It is preferable to separate the heating block 16 and hood-equipped gas supply tube 13 from each other as far as possible, because the gas flowing through the gas supply tube 13 may be reacted by the accumulated heat in the heating block 16 and the resultant solid product may be deposited on the inner walls, when they are sufficiently close to each other. In order to

increase temperature of the heating block 16 for preheating PH_3, the gap 18 in the RF heating coil 17 can be narrowed.

The crystal is grown to a thickness of approximately 3 to 5μm in an hour under the following conditions: TEI (heated at 50°C) is bubbled with H_2 flowing at 100cc/minute, a H_2-based gas containing 2% of PH_3 is charged at 200cc/minute while being carried by H_2 flowing at 1l/minute, and crystal growth temperature and the vicinity of the heating block 16 for Preheating PH3 are set 600 and 700°C, respectively. This growth rate is several tens times faster than that attained by the conventional device.

The above example mentions the InP-based vapor phase deposition. It is however needless to say that the present invention is also applicable to the epitaxial growth of another compound to have a semiconductor layer, so long as it undergoes the reaction process similar to that associated with an InP-based compound.

As described above, this example gives a layer of grown InP-based crystal faster, because it guides an organometallic compound, e.g., TEI, by a hood-equipped gas supply tube and supplies the preheated gas, e.g., PH_3 gas, onto the substrate. In addition, the gas supply tube and heating block for preheating can be attached to, or detached from, the device, facilitating cleaning of the tube inside.

Therefore, the present invention can form a high-quality

growth layer at a high speed, in spite of its simple structure, and is suitable for massive production of the growth layer of a compound semiconductor of Group III and V elements or II and VI elements. As such, it has high industrial value.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig.1 outlines the conventional vapor deposition device, and Fig.2 the vapor deposition device of the present invention described by the example,

wherein, 1: reactor core tube, 7: boat, 8: susceptor, 9: substrate, 13: hood-equipped gas supply tube, 14: hood, 15: gas supply tube and 16: graphite block.